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(71) Applicant:
Charles William Simcoe
211 Sunset Drive, Tulsa, Oklahoma 74114, United States of America

(72) Inventor:
Charles William Simcoe

(74) Agent and/or Address for Service
Potts Kerr & Co., 15 Hamilton Square, Birkenhead, Merseyside L41 6BR

(54) Hinged intraocular lens

(57) A hinged intraocular lens for implantation in the anterior chamber, posterior chamber or capsular bag of the eye after cataract extraction has at least one lens centering member extending from the lens periphery for supporting the lens within the eye, the centering member being formed of a hinged portion (32, 32A, 32B) secured to the lens and being formed of relatively thin cross-sectioned, highly flexible material, and a contact portion 34, 34A, 34B mode of a material different from the hinge portion and having high biological tolerance for non-irritating engagement with the eye.

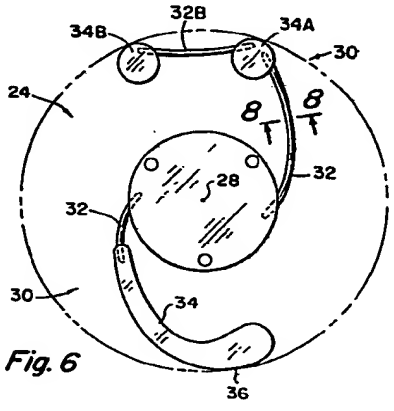

Fig. 6

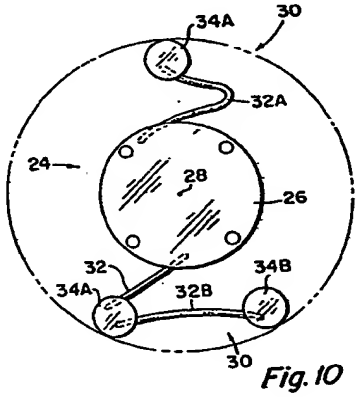

Fig. 10

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IDS

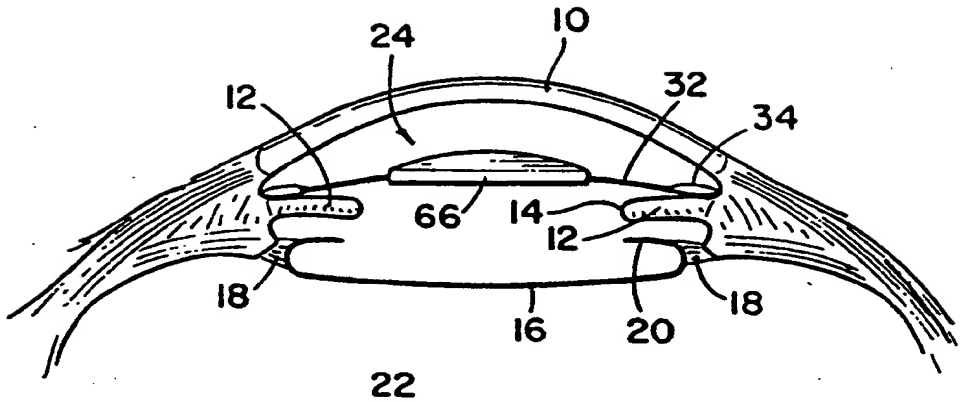

Fig. 1

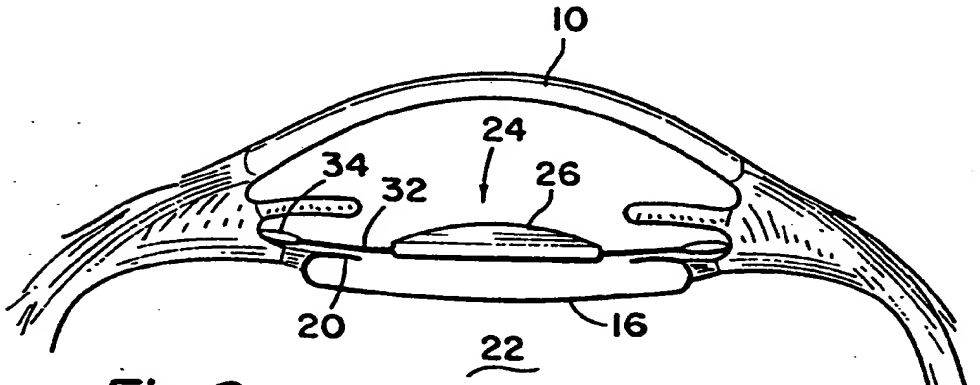

Fig. 2

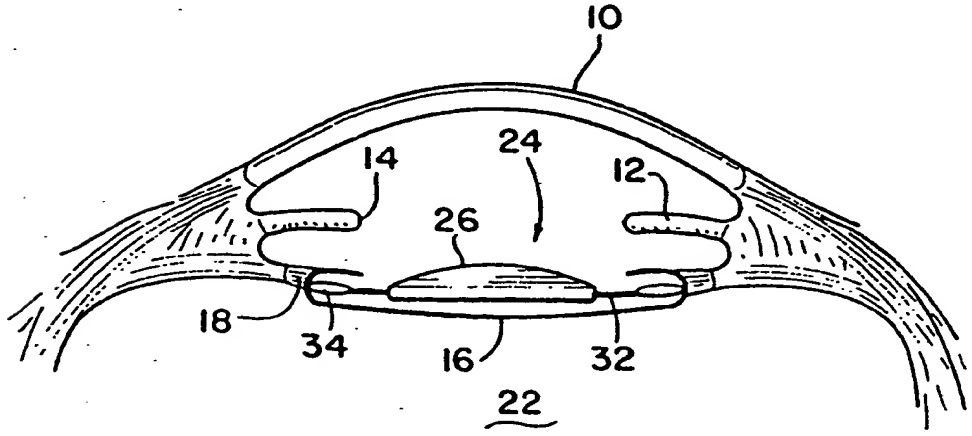

Fig. 3

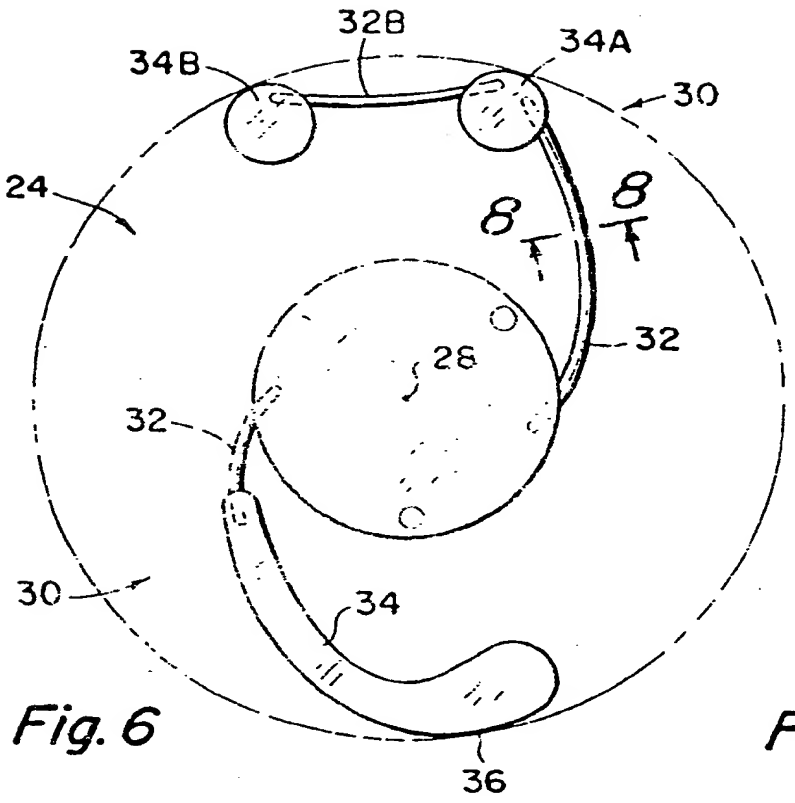

Fig. 6

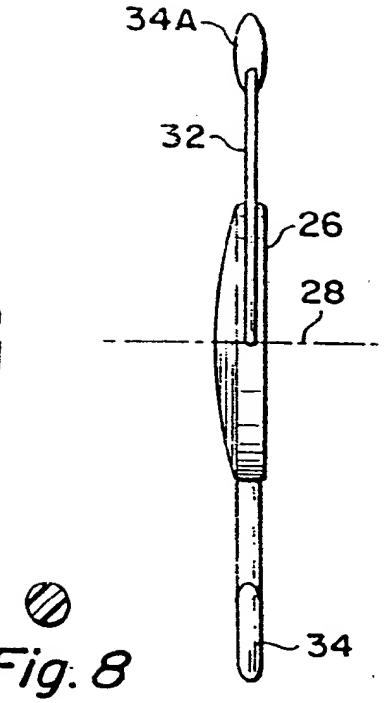

Fig. 7

Fig. 8

Fig. 8A

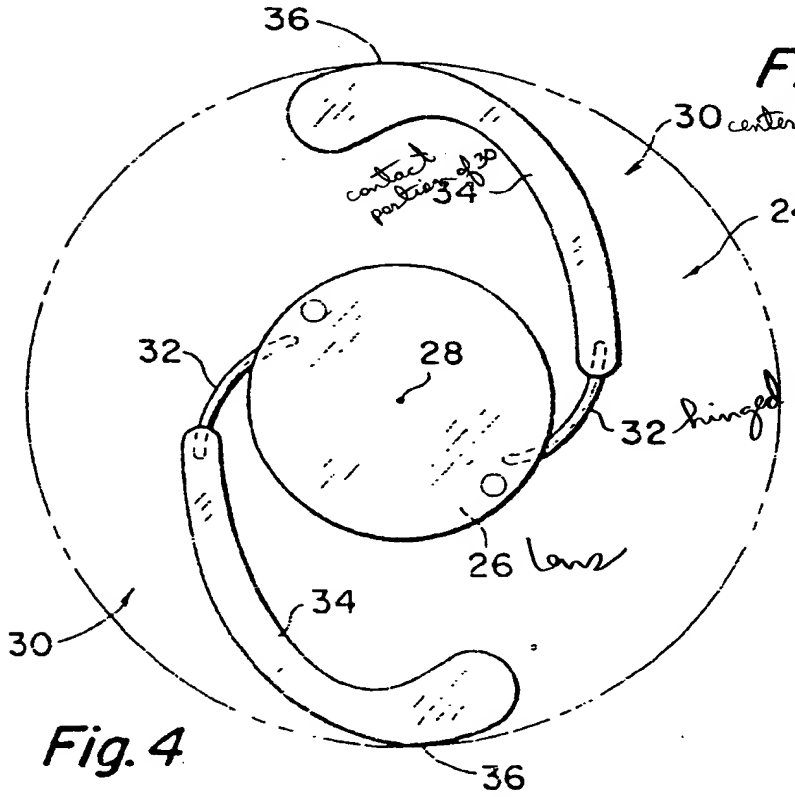

Fig. 4

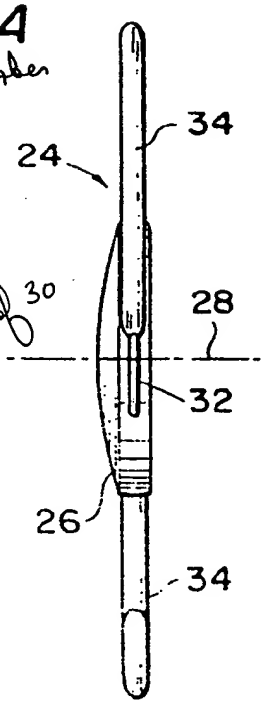

Fig. 5

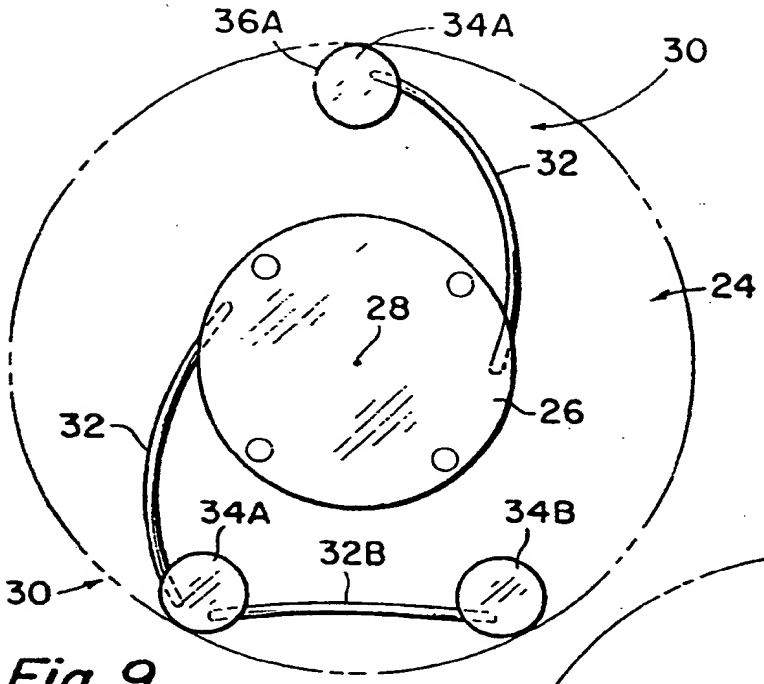

Fig. 9

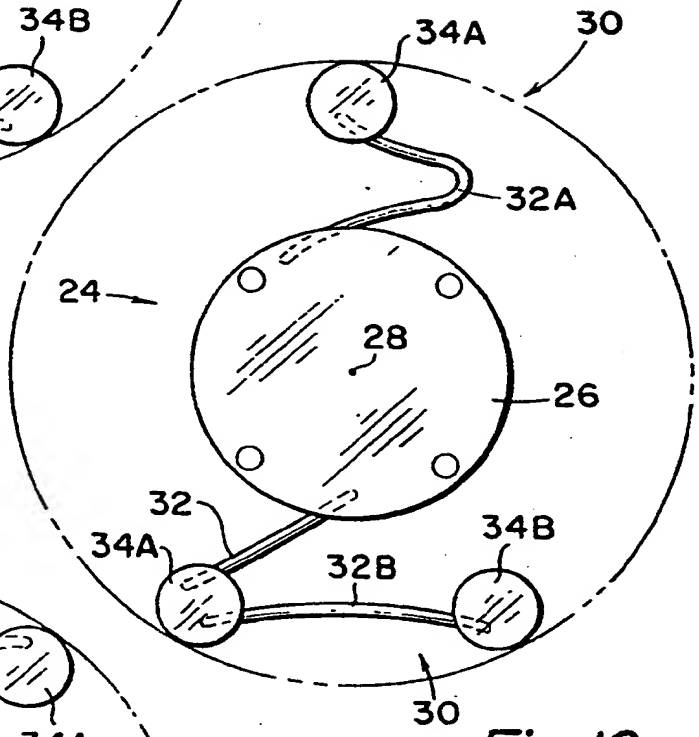

Fig. 10

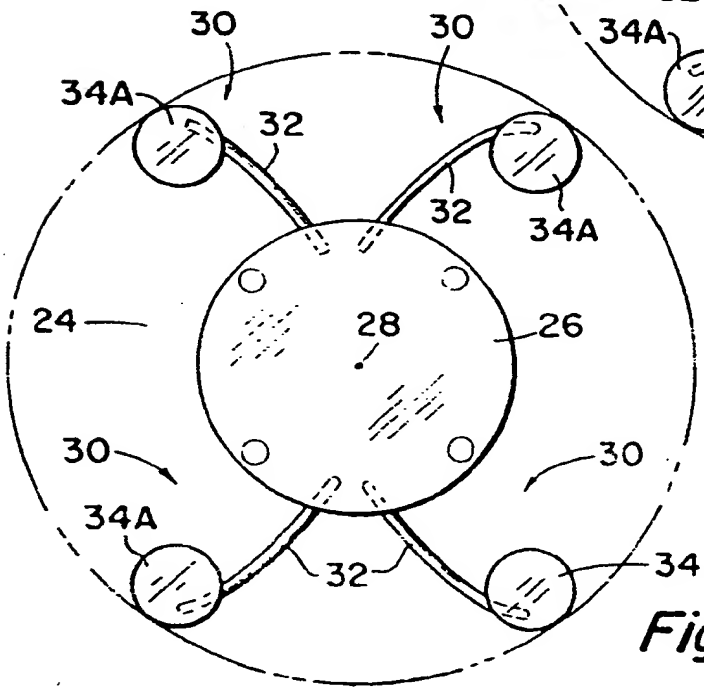

Fig. 11

SPECIFICATION

Hinged intraocular lens

The use of intraocular lenses is well known and a variety of different lens configurations have been devised. Generally, such intraocular lenses include a central lens member having an optical axis with lens centering members extending from it. These centering members serve to retain the lens in position within the eye and in alignment with the pupillary opening in the iris.

The lens centering members extend outwardly from the lens and engage portions of the eye in one of three locations, or a combination of these, that is, in the anterior chamber which is between the iris and the cornea, the posterior chamber which is rearwardly of the iris and forwardly of the capsular bag and a third position which is within the capsular bag.

The lens centering members which have proven successful for supporting artificial lenses in the human eye have been of different types. In one type a plurality of loop members usually two, three or four, formed of small diameter flexible material extend from the periphery of the lens and perform the dual function of providing flexibility to retain the lens in proper position and to contact the eye by which the support function is provided. In another type the lens material itself has integrally formed extending loop portions, or other supporting elements.

The existing lens configurations have proven successful to some extent, however, some difficulties and limitations exist. The support members perform different functions. They must, for the most comfortable and successful application of intraocular lenses, be sufficiently flexible so as to adapt a lens to slightly varying dimensions of the eye. The lens support members provide physical contact with the eye to function as a stabilizing base for the lens. When a foreign material contacts any portion of the human body the possibility for adverse reaction exists. Thus, unless the portion of the support member which contacts the eye is biologically tolerable, irritation, inflammation and other possible adverse reactions can occur. The varying functions of the lens support members are not necessarily obtainable from the same material and in the past a compromise has been required in selecting the materials of which the lens supporting members are formed. The present invention provides design principles applicable to many intraocular lens including specifically, improved lens centering members. These lens centering members, usually multiple, extend away from the lens such as with existing intraocular lenses, however, the lens support members are formed of multiple pieces, that is, a hinge portion or portions and a contact portion or portions. The hinge portion or portions connect the contact portion or portions with the lens. The hinge portion does not necessarily contact any portion of the eye and therefore the materials selected can be those which offer the optimal flexibility at appropriate size and weight and therefore may be of any material such as plastic, fiberglass, metal and so forth.

The contact portions are not required to be flexible in the design of this invention and may therefore be of materials other than those of the hinge portion. The contact portions are preferably configured to be non irritating. The contact portions in contrast with the hinge portion are not necessarily required to be resilient but should be biologically tolerant. This permits the use of materials which have a low body rejection characteristic.

Figure 1 is a cross-sectional view of the forward portion of the human eye showing an intraocular lens of this invention as implanted in the anterior chamber position.

Figure 2 shows a lens in the posterior chamber position.

Figure 3 shows a lens of this invention as positioned in the capsular bag.

Figure 4 is a front view of a lens of this invention employing the hinging principal.

Figure 5 is a side view of the intraocular lens of Figure 4.

Figure 6 is a front view of an alternate embodiment of the invention showing the arrangement wherein one of the lens centering members employs two hinge portions and two contact portions.

Figure 7 is a side view of the lens of Figure 6.

Figure 8 is a cross-sectional view taken along the line 8-8 of Figure 6 showing the cross-section of the hinge portion of the lens.

Figure 8A is a cross-sectional view as in Figure 8 but showing an alternate cross-sectional arrangement of the hinge portion.

Figure 9 is a front view of another lens employing the principles of this invention.

Figure 10 is an additional alternate embodiment of the invention wherein one of the hinge members is of recurved configuration.

Figure 11 is still another alternate embodiment of the invention wherein four lens centering members are employed, each including a hinge portion and a contact portion.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:—

Referring first to Figure 1, 2 and 3 cross-sectional views of the front portion of the human eye are shown to illustrate the environment in which the intraocular lens of the invention is employed and to illustrate the importance of certain features of the invention. In Figures 1, 2 and 3 the basic portions of the eye shown include the cornea 10, the iris 12 with the pupillary opening through the iris being indicated by the numeral 14, the capsular bag posterior surface 16 and the suspensory ligaments 18. The natural lens, which is a crystalline structure, has been removed from the capsular bag 16 in which it is normally housed. The anterior wall 20 of the capsular bag is shown broken as is required for the removal of the natural lens. Rearwardly of the capsular bag posterior walls 16 is the vitreal chamber 22.

The invention is directed towards intraocular lenses

for positioning in the eye to achieve the function formerly accomplished by the naturally occurring lens, (not shown) which has been removed from the capsular bag 16 or in which the lens and capsular bag have been removed in their entirety (intracapsular cataract extraction). The lens of this invention is generally indicated by the numeral 24 and may be positioned in one of three areas in the eye as illustrated in Figures 1, 2 and 3. Figure 1 shows the lens 24 in the anterior chamber, that is, between the iris 12 and the cornea 10. Figure 2 shows a lens 24 in the posterior chamber, rearwardly of the iris and forwardly of the capsular bag 20. Figure 3 shows a lens 24 in the capsular bag. The construction of the lenses for these various locations employ the basic concepts of the invention, but vary in detail. For instance, when the lens is in the anterior chamber as in Figure 1 the lens may vault forward whereas in the posterior chamber in Figure 2 it may vault rearwardly in a manner which will be described subsequently.

Referring to Figures 4 and 5 an embodiment of the lens is illustrated. The lens 24 includes an optical lens 26 formed of a biologically tolerable optically suitable material, usually of plastic. The lens, as seen in the side view of Figure 5, is a disc curved to provide the proper optical properties to direct light passing through it onto the retina of the eye. The lens 26 has an optical axis 28.

Affixed to the lens 26 is a plurality of spaced apart centering members generally indicated by numeral 30. The number of centering members depends upon the particular design of the lens and will normally be two, three or four. Each of the centering members is formed of two parts, that is, a hinge portion 32 and a contact portion 34. The hinge portion 32 is made of a highly flexible material and may be configured of cross-sectional shape so as to augment the flexibility and thereby the hinging action of the member. The hinge portion 32 may be made of a material such as plastic, fiberglass, metal or other suitable materials. Regardless of the material chosen it is desirable that it be biologically tolerable; however, the hinge portion does not require the high degree of biological tolerance as is necessary in the contact portion 34, since in the normal application of the lens the hinge portion 32 is usually not in direct physical contact with any portion of the eye.

As shown in Figure 8 the cross-sectional of a hinge portion 32 may be circular or as in Figure 8A, may be non-circular, such as elliptical. The configuration of Figure 8A is advantageous in that the cross-section permits a high degree of flexibility in selectively desired planes but less flexibility in undesired planes. This means that the configuration of the hinge portion 32 when of the cross-section of Figure 8A resists movement of the lens forwardly and rearwardly along the path of the optical axis, but is highly flexible to keep the lens comfortably centered in alignment with the pupillary opening 14.

In the embodiment of the invention as shown in Figures 4 and 5 and in the lower centering members 30 in Figure 6 and 7, the contact portion 34 is of an elongated curve providing a smooth arcuate surface 36 which physically engages the eye. In the anterior chamber placement of Figure 1 the surface 36 engages the periphery of the anterior chamber anteriorly of the iris. In the posterior chamber placement of Figure 2 the surface 36 engages the peripheral area posteriorly of the iris in the area called the ciliary sulcus. In the placement of Figure 3 the arcuate surface 36 engages the interior peripheral surface of the capsular bag. It is exceedingly important that the material of which the contact portion 34 is formed be that which has a high biological tolerance so that there is minimal body reaction to the permanent contact of this surface against the occular tissues.

As can be seen in Figures 5 and 7 the thickness of the contact portion 34 is greater than that of the hinge portion 32. While this is not absolutely necessary, nevertheless this arrangement points out the fact that the provision of forming each of the centering members 30 of separate hinge and contact portions allow configuration of the portions so that the hinge portion is designed specifically to serve its function and the contact portion is defined to serve specifically its function, that is, providing physical engagement with the natural body surfaces of the eye in a manner to provoke the least irritation.

The specific geometrical configuration of the contact portion 34 of each centering member is subject to a variety of designs. Figure 9 shows in the upper portion of the drawing the arrangement wherein the contact portion 34 is in the form of a disc and the arcuate surface 36A is the periphery of the disc. Needless to say that a large variety of other configurations can be devised.

As previously indicated the number of centering members 30 may vary from two or more with, two, three or four being desirable. Figures 4, 6, 9 and 10 show the arrangement wherein two centering members 30 are employed. Figure 11 shows the arrangement wherein four such centering members are utilized each formed of two portions; that is, a hinge portion 32 and a contact portion 34A. The contact portion being in the form of a small flat disc with rounded surfaces of the type shown at the upper portion of Figure 7. Obviously the design of Figure 11 could be accomplished utilizing three centering members 30 equally spaced from each other or wherein one is spaced opposed to the center point between the other two.

As the specific configuration of the contact portion 34 may vary, in like manner the specific configuration of the hinge portion 32 may also change while nevertheless keeping within the spirit and scope of this invention. Figure 10, in the upper portion thereof, shows an arrangement wherein the hinge portion 32A is bent into a recurved configuration as seen in a plane perpendicular the lens optical axis 28. The highly flexible hinge portion 32A provides a resilient force serving to keep the lens centered with respect to the pupillary opening and thereby accomplishes the same results as the arcuate configured hinge portions 32 of Figures 9 and 11.

Figures 6, 9 and 10 show an alternate embodiment of the invention. Each of these embodiments illustrates one of the centering members provides for two spaced apart contact portions. Referring specifically to Figure 6, the upper centering member 30 is formed of a first hinge portion 32, a first contact portion 34A, a

second hinge portion 32B and a second contact portion 34B. Each of the contact portions 34A and 34B are of the small disc type as previously described although obviously the practice of the invention would not be limited to such specific geometrical shape. The arrangement of the upper portion of Figure 6 has a significant advantage in intraocular lens construction in that it provides means of achieving a three point contact for better stability of the lense in the eye while each contact is independently hinged relative to the lens and employing only two centering members. The advantage of more than two contact areas to support the lens is that it is necessary that the lens be supported in such a way that the optical axis remains substantially fixed relative to the eye and preferably so that the optical axis substantially intersects the central fovea (not shown in the drawings). While a three point contact is desirable the use of the fewest number of centering members 30 may also be desirable since it simplifies not only the construction of the lens but the positioning of it in the eye of the patient.

The arrangement of the upper portion of Figure 6 using highly flexible hinge portions 32 and 32B means that both the contact portion 34A and 34B are resiliently biased for engagement with the eye but in a manner to limit the physical force of the contact while at the same time providing force necessary to keep lens 24 centred as required.

Figure 9 shows the two contact double hinged centering member 30 as in Figure 6 but in the lower portion of the lens and in like manner the two contact two hinge centering member is shown in the lower portion of Figure 10. In Figure 10 the first hinge portion 32 extends a direction opposite that of Figure 9, illustrating the fact that the orientation of the highly flexible hinge portion can vary while nevertheless providing the resilient contact necessary for proper positioning the lens in the eye.

The intraocular lens as illustrated and described may be termed a "three piece lens", that is, the three basic portions consisting of the lens 24, hinge 32 and contact portion 34 can be made of different materials. The lens 26 obviously must be of a material having the high quality optical properties desired which is not relevant to the other two portions. The hinge portion 32 needs to be exceedingly flexible, which property is not necessary in the other two portions. The contact portion 34 needs to be of a material highly biologically tolerable which, while desirable in the other two portions is not as critical since only the contact portion 34 must be in physical contact with the eye of the user. The invention thereby adapts itself to utilization of the best possible materials for the separate functions of the intraocular lens.

CLAIMS

1. An intraocular lens for implantation in the anterior chamber, posterior chamber or the capsular bag of the eye after cataract extraction, comprising an optical lens formed of a biologically tolerable, optically suitable material, having an optical axis and at least one lens centering member extending away from the optical axis of the lens for supporting the lens within the eye, such lens centering member being formed of a hinge portion and a contact portion, the hinge portion having an inner end secured to the lens, the hinge portion being of a flexible material, the hinge portion outer end being affixed to said contact portion, the contact portion being of material different from said hinge portion and having high biological tolerance and of peripheral configuration for engagement with the occular tissue.

2. A lens as claimed in claim 1, in which the centering member hinge portion is configured in cross-section to have more flexibility in a selected plane and less flexibility in other selected planes.

3. A lens as claimed in claim 1 or 2, in which each lens centering member contact portion is of plastic material having cross-sectional thickness greater than the cross-sectional thickness of said hinge portion.

4. A lens as claimed in claim 1, in which the lens centering member hinge portion is of a material selected from the group comprising metal, plastic and fiberglass.

5. A lens as claimed in claim 1, in which the contact portion of the lens centering member is disc shaped, the plane of the disc being generally parallel a plane perpendicular the lens optical axis.

6. A lens as claimed in claim 1, in which the contact portion of the lens centering member is of elongated arcuate configuration.

7. A lens as claimed in claim 1, in which the lens centering member hinge portion is of recurved configuration whereby the contact portion is substantially directly radially displaceable relative to the lens.

8. A lens as claimed in any preceding claim, in which the hinge member is affixed at one end to the lens and extends away from the lens optical axis, the contact member is affixed to the other end of the hinge member, a second hinge member being affixed at one end to the contact member and a second contact member being affixed to the other end of the second hinge member, the hinge members being of flexible material and configuration and the contact members being of material different than the hinge member and having high biological tolerance and being of configuration for non-irritating engagement with the occular tissue, the contact members serving to engage portions of the occular tissue in spaced apart relationship.

9. A lens as claimed in claim 8, in which the centering member hinge portions are each configured in cross-section to have more flexibility in a selected plane and less flexibility in other selected planes.

10. A lens as claimed in claim 8, in which each contact portion is of plastic material having cross-sectional thickness greater than the cross-sectional thickness of the hinge portions.

11. A lens as claimed in claim 8, in which each lens centering member hinge portion is of a material selected from the group comprising metal, plastic and fiberglass.

12. A lens as claimed in claim 8, in which each contact portion of the lens centering member is disc shaped, the plane of the disc being generally parallel a plane perpendicular to the lens optical axis.

13. An intraocular lens constructed and arranged substantially as herein described with reference to and as illustrated in any of the Figs. of the accompanying drawings.

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